NOISE STUDY REPORT

San Diego Freeway (I-405) Improvement Project
SR-73 to I-605

Orange and Los Angeles Counties

12-ORA-405 PM 9.3/24.2 / 07-LA-405 PM 0.0/1.2
12-ORA-22 PM R0.7/R3.8 / 12-ORA-22 PM R0.5/R0.7
12-ORA-73 PM R27.2/R27.8 / 12-ORA-605 PM 3.5/R1.6
07-LA-605 PM R0.0/R1.2

EA 0H1000
EFIS ID 1200000180

June 2011

Caltrans

STATE OF CALIFORNIA
Department of Transportation

Noise Study Report

In Orange County from SR-73 to the I-605 Interchange

12-ORA-405 PM 9.3/24.2 / 07-LA-405 PM 0.0/1.2
12-ORA-22 PM R0.7/R3.8 / 12-ORA-22 PM R0.5/R0.7
12-ORA-73 PM R7.1/R8.0 / 12-ORA-605 PM 3.5/R1.6
07-LA-605 PM R0.0/R1.2

12-0H1000

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Summary

The purpose of this Noise Study Report (NSR) is to evaluate traffic noise impacts and abatement under the requirements of Title 23, Part 772 of the Code of Federal Regulations (Title 23 CFR 772) “Procedures for Abatement of Highway Traffic Noise”. Title 23 CFR 772 provides procedures for preparing operational and construction noise studies as well as evaluating noise abatement considered for federal and federal-aid highway projects. According to Title 23 CFR 772.3, all highway projects that are developed in conformance with this regulation are deemed to be in conformance with Federal Highway Administration (FHWA) noise standards.

The California Department of Transportation—District 12 (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA), proposes to improve mainline freeway and interchanges on I-405 in Orange County for approximately 16 miles between Post Mile (PM) 9.3 – State Route 73 (SR-73) and PM 24.2 – Interstate 605 (I-605). The proposed project would relieve congestion on I-405 between SR-73 and I-605; enhance interchange operations; increase mobility, improve trip reliability, maximize throughput, and optimize operations; implement strategies that ensure the earliest project delivery; and enhance traffic safety.

A No Build Alternative and three Build Alternatives are being considered. The No Build Alternative provides a “baseline” for comparing impacts associated with the build alternatives. The baseline conditions under the No Build Alternative would provide no additional lanes or interchange improvements to the I-405 corridor. The project area would continue to operate with no additional improvements with the exception that following two committed projects would be implemented: SR 22 West County Connectors Project (EA 071631) and a project that would provide continuous ingress and egress from the HOV lanes for the entire length of I-405 in Orange County (EA 0J440K).

Build Alternative 1 would entail the construction of one general purpose (GP) lane in each direction of the I-405 extending from Euclid Street to the I-605 interchange. To ensure efficient and safe merge and diverge operations, auxiliary lanes would also be constructed. In addition, a number of interchange improvements are planned. A total of 16 local street overcrossings which span the I-405 would require replacement to accommodate the new GP lane.

Build Alternative 2 would entail the construction of one GP lane in each direction of I-405 extending from Euclid Street to the I-605 interchange. In addition, a second lane in the northbound direction from Brookhurst Street to the SR 22/7th Street interchange would be constructed. A second lane in the southbound direction from the Seal Beach Boulevard on-ramp to Brookhurst Street would also be constructed. To ensure efficient and safe merge and diverge operations, auxiliary lanes would also be constructed. In addition, a number of interchange improvements are planned. A total of 16 local street overcrossings which span I-405 would require replacement to accommodate the new GP lanes.

Build Alternative 3 would add one GP lane in each direction of I-405 from Euclid Street to the I-605 interchange (as in Alternatives 1 and 2), plus add a tolled express lane in each direction of I-405 from SR-73 to I-605. The tolled express lane would be placed beside the existing high occupancy vehicle (HOV) lane in each direction. The existing HOV lanes and new toll lanes would be managed jointly as an Express Lane Facility with two lanes in each direction.

Land uses along the I-405 project corridor are predominantly residential with pockets of commercial and recreational parcels as well as various schools and hotels. Topography along the corridor is relatively flat where the majority of local traffic roadways cross over I-405. Traffic on I-405 is the dominant source of noise in the area. The noise study divided the project alignment into six distinct segments for analysis purposes. These segments are based on major local interchanges. The six segments are: 1) I-405 – south of Bristol Street to Euclid Street; SR-73 – south to Bear Street; 2) I-405 – Euclid Street to Magnolia Street; 3) I-405 – Magnolia Street to Bolsa Avenue / Goldenwest Street; 4) I-405 – Bolsa Avenue / Goldenwest Street to SR-22 / Valley View Street; SR-22 – east to Springdale Street; 5) I-405 – SR-22 / Valley View Street to Seal Beach Boulevard; and 6) I-405 – Seal Beach Boulevard to I-605; I-605 – north to south of Katella Avenue.

Noise measurements were conducted at selected locations to evaluate the existing noise environment and to calibrate the traffic noise model. Short-term noise monitoring was conducted at 61 locations in June 2010, and one additional location in August 2010; using Type 1 sound level meters. Measurements were taken for a duration of 20-minutes at each site. Meteorological conditions (temperature, wind speed and direction, relative humidity) were logged for each measurement session using a hand-held weather station. Long-term noise monitoring was conducted at 30 locations using Type 1 sound level meters for a duration of at least 24 hours. Concurrent with the collection of sound level data at 32 locations, traffic counts on I-405 were also performed. Traffic was counted on I-405 and ramps near a measurement site and classified by vehicle type (e.g. autos, medium trucks, heavy trucks). The purpose of the field traffic counts is to calibrate the TNM 2.5 model so that the prediction of future noise levels can be made more accurately. Measured hourly averaged peak hour noise levels ranged from 54 to 73 dBA.

Level of service (LOS) C and year (2040) forecasted traffic information were utilized to predict traffic noise levels and analyze noise impacts at receivers located on both sides of the freeway. In general, modeled noise levels were higher than measured noise levels ranging typically from 0 to 2 dB and up to 10 dB above the existing peak hour noise levels. However, there are some areas where the measured noise levels were higher than the modeled noise levels by as much as 7 dB. These situations are generally caused by some construction feature such as an overcrossing embankment or a retaining wall that would provide traffic noise shielding in the future case that currently does not exist. The range of predicted future traffic noise levels with project under Alternative 1 is 52 to 79 dBA. Alternative 2 predicted future traffic noise levels range from 53 to 80 dBA, and the range for Alternative 3 is 52 to 80 dBA.

This report analyzes noise barriers with heights from 8 to 16 feet to determine feasible noise abatement. Soundwalls are considered feasible when they provide at least 5 dB noise reduction. In most areas, there are either existing soundwalls that will remain intact or soundwalls that will need to be replaced as part of the project. For those soundwalls which will remain intact because the project widening will not encroach upon them, analysis was conducted for barrier heights above the existing heights at the same location. For soundwalls which will need to be demolished due to the widening of the alignment or due to other construction details such as the construction of retaining walls, it has been assumed that in-kind replacement soundwalls will be constructed as part of the project. These in-kind replacement soundwalls would be the same length and height as the soundwall it is replacing but at a new and typically similar location and have been included in the noise analysis. The noise prediction analysis with barrier of these in-kind replacement soundwalls are of heights that are greater than the in-kind heights.

The identified feasible soundwalls fall into one of three categories: 1) new soundwalls, 2) soundwalls which would be in-kind replacements with greater heights at new locations due to the project widening, and 3) extensions of either existing soundwalls or in-kind replacement soundwalls. There will be several soundwalls that would not be considered feasible that need to be considered because they are either an in-kind replacement or an extension soundwall. The extension soundwalls are needed where the reconfigured embankments would increase the exposure of nearby frequent outdoor use areas to freeway traffic noise and these soundwalls would provide protection from the increased exposure to freeway traffic noise. The following summarizes the soundwalls identified for each alternative:

Alternative 1: Total Number of Soundwalls = 48

- Number of Feasible Soundwalls = 32
- Number of Non-Feasible Soundwalls = 16

Alternative 2: Total Number of Soundwalls = 51

- Number of Feasible Soundwalls = 32
- Number of Non-Feasible Soundwalls = 19

Alternative 3: Total Number of Soundwalls = 56

- Number of Feasible Soundwalls: 33
- Number of Non-Feasible Soundwalls: 23

Throughout the project limits, there are two areas under Alternative 1 and four areas under Alternatives 2 and 3 where the predicted peak hour noise level is at or above 75 dBA; therefore, these residences would be considered severely impacted. Where severe impacts are identified, unusual and extraordinary abatement must be considered. If the soundwall is determined to be unreasonable based on cost, providing the soundwall will still be required for these residences.

Construction noise control shall conform to the provisions in Section 14-8.02, "Noise Control," of the Standard Specifications and S5-310 “Noise Control” of the Standard Special Provisions. The requirements state that all equipment shall be fitted with adequate mufflers and operated according to the manufacturers’ specifications. Construction noise varies greatly depending on the construction process, type and condition of equipment used, as well as layout of the construction site. Temporary construction noise impacts would be unavoidable at areas located immediately adjacent to the proposed project alignment.

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List of Abbreviated Terms

CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CIDH	Cast-in-drilled-hole
CNEL	Community Noise Equivalent Level
dB	Decibels
ED	Environmental Document
FHWA	Federal Highway Administration
GP	general purpose
HOV	high-occupancy vehicle
Hz	Hertz
kHz	Kilohertz
L_{dn}	Day-Night Level
L_{eq}	Equivalent Sound Level
$L_{eq(h)}$	Equivalent Sound Level over one hour
L_{max}	Maximum Sound Level
LOS	Level of Service
L_n	Percentile-Exceeded Sound Level
μPa	micro Pascals
mph	miles per hour
NAC	Noise Abatement Criteria
NADR	Noise Abatement Decision Report
NEPA	National Environmental Policy Act
NSR	Noise Study Report
Protocol	Caltrans Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects
PSR	Project Study Report
PTE	Permit to Enter
RTP	Regional Transportation Plan
SCAG	Southern California Association of Governments
SPL	sound pressure level
SR	State Route
TeNS	Caltrans' Technical Noise Supplement
TNM 2.5	FHWA Traffic Noise Model Version 2.5

Chapter 1. Introduction

1.1. Purpose of the Noise Study Report

The purpose of this Noise Study Report (NSR) is to evaluate noise impacts and abatement under the requirements of Title 23, Part 772 of the Code of Federal Regulations (Title 23 CFR 772) "Procedures for Abatement of Highway Traffic Noise". Title 23 CFR 772 provides procedures for preparing operational and construction noise studies and evaluating noise abatement considered for federal and federal-aid highway projects. According to Title 23 CFR 772.3, all highway projects that are developed in conformance with this regulation are deemed to be in conformance with Federal Highway Administration (FHWA) noise standards.

The California Department of Transportation (Caltrans) Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects (Protocol) (Caltrans, 2006) provides Caltrans policy for implementing Title 23 CFR 772 in California. The Protocol outlines the requirements for preparing noise study reports (NSR) in support of State highway projects. Noise impacts associated with this project under the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA) are evaluated in the I-405 Improvement Project Environmental Document (ED).

The project area has been divided into six distinct segments for noise analysis purposes. The following are these segments, which are based on major local interchanges:

1) I-405 – south of Bristol Street to Euclid Street; SR-73 – south to Bear Street
2) I-405 – Euclid Street to Magnolia Street
3) I-405 – Magnolia Street to Bolsa Avenue / Goldenwest Street
4) I-405 – Bolsa Avenue / Goldenwest Street to SR-22 / Valley View Street; SR-22 – east to Springdale Street
5) I-405 – SR-22 / Valley View Street to Seal Beach Boulevard
6) I-405 – Seal Beach Boulevard to I-605; I-605 – north to south of Katella Avenue

The study includes (a) short-term measurements; (b) long-term noise measurements; (c) roadway traffic noise modeling using FHWA's Traffic Noise Model 2.5 (TNM 2.5); and (d) feasible noise abatement measures which included new soundwalls and specifications for in-kind replacement soundwalls.

1.2. Project Purpose and Need

I-405 is considered a bypass route to the Interstate 5 (I-5) Santa Ana/Golden State Freeway through Orange County and an important component of the county's transportation system. Within Orange County, I-405 extends 24 miles northwesterly from I-5 freeway in Mission Viejo to the Los Angeles/Orange County line. I-405 is a controlled access facility with a fenced right-of-way (ROW) separated by grade from crossing traffic, with vehicular access limited to interchanges. Within the project area, I-405 crosses (or is adjacent to) residential, commercial, recreational, and industrial urbanized uses that have developed directly up to the Caltrans' ROW boundary.

Figure 1-1 shows the project's regional vicinity location and Figure 1-2 shows the project's location. Figure 1-2 identifies a quarter-mile buffer area for the proposed action, including portions of SR-73 and I-605. Within the proposed project limits, I-405 currently consists of eight to 12 mixed-flow general purpose (GP) lanes, two high occupancy volume (HOV) lanes, auxiliary lanes along selected portions of the route, and 21 arterial crossings.

The project area is in an urbanized setting with commercial office towers at the southern end of the project in Irvine and suburban, single family residences in the northern end in Seal Beach. There are eight incorporated cities within the project area: Costa Mesa, Fountain Valley, Garden Grove, Huntington Beach, Long Beach, Los Alamitos, Seal Beach, and Westminster, and also the unincorporated community of Rossmoor. Approximately 1.2 miles of the I-605 facility north of Katella Avenue is in Los Angeles County. However, no new lanes are added to this portion of the project; therefore, the noise study has stopped just south of Katella Avenue.

The purpose of the proposed action is to:

- Add capacity and reduce congestion on the GP and HOV lanes along the entire I-405 corridor from SR-73 to I-605;
- Enhance interchange operations;
- Increase mobility, improve trip reliability, maximize throughput, and optimize operations;
- Implement strategies that ensure the earliest project delivery; and
- Enhance safety.

In furtherance of the project's purpose, the following objectives are established:

- Minimize ROW acquisition;
- Ensure financial viability;
- Meet, at a minimum, the commitments of Orange County's Renewed Measure M transportation sales tax initiative to add capacity to the I-405 within the project area;
- Maintain or improve future traffic performance within the corridor; and
- Improve the corridor so as to ensure the facility is maintained as an effective link in the National Strategic Highway Network.

Current deficiencies of I-405 within the project limits are summarized below:

- The I-405 mainline GP lanes peak period traffic demand exceeds available capacity;
- The I-405 mainline HOV lanes peak period traffic demand exceeds available capacity;
- The I-405 mainline GP traffic lanes have operational and geometric deficiencies;
- The interchanges along I-405 within the study area have geometric, storage, and operational capacity deficiencies; and
- I-405 currently has limitations in detecting traffic incidents and providing rapid response and clearance (due to lack of capacity and technological infrastructure).

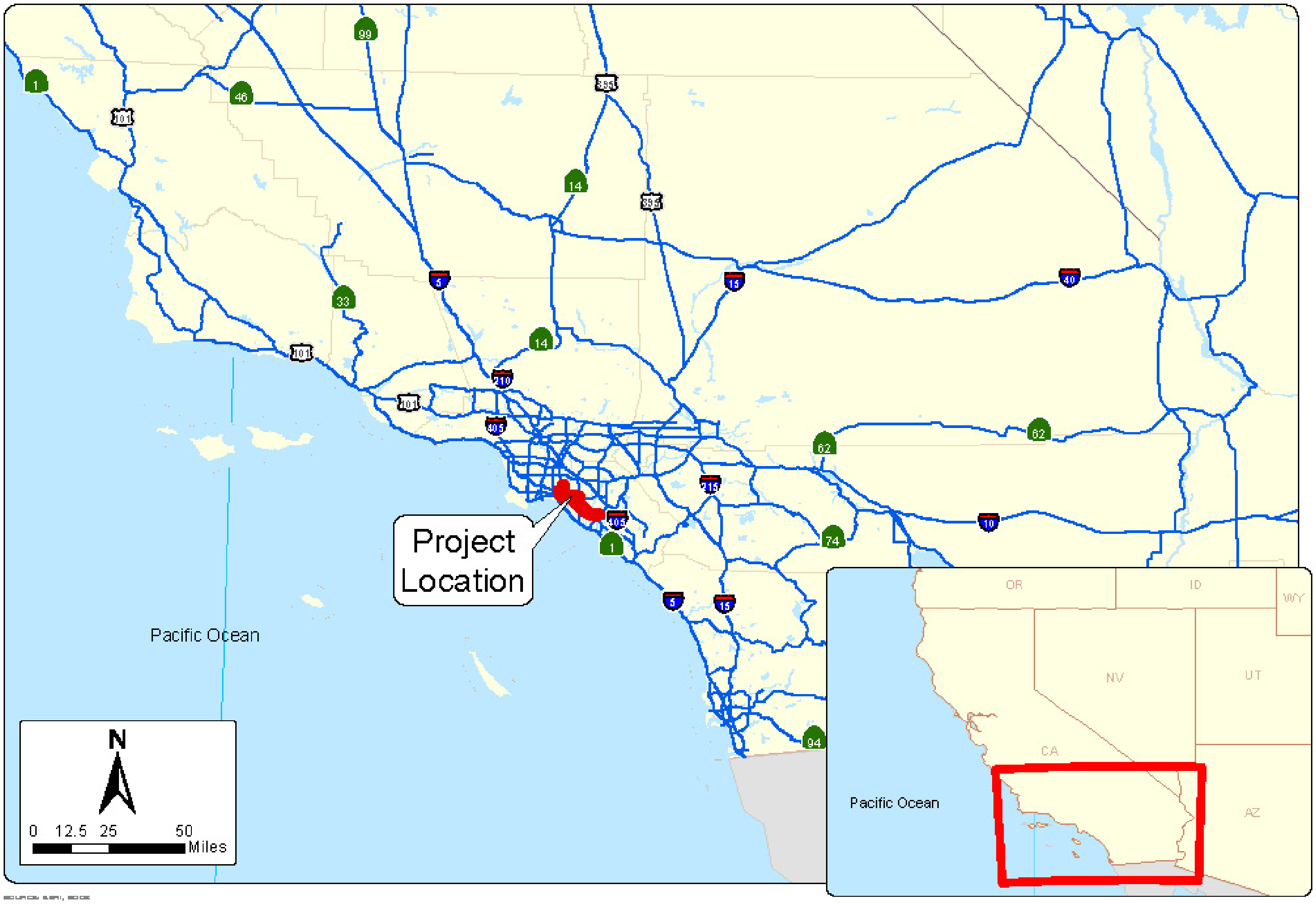


Figure 1-1. Regional Vicinity Map

Source: Parsons 2010

Figure 1-2. Project Location Map

Projected population and employment growth trends indicate that transportation demand in the I-405 corridor will continue to increase in future years, exacerbating capacity deficiencies. With the forecast future growth of traffic volumes along the I-405 corridor, level of service (LOS) is expected to degrade further, even with implementation of the following two committed projects along the I-405 corridor:

- An additional HOV lane in each direction between SR-22 East and I-605, including HOV direct connectors at I-405/SR-22 East and I-405/I-605 (EA 071631); and
- Providing continuous ingress and egress from the HOV lanes for continuous ingress and egress from the HOV lanes on the entire length of I-405 in Orange County the entire length of I-405 in Orange County (EA 0J440K).

The geometric and operational deficiencies within the project corridor also pose potential safety concerns, and are incompatible with the goals of the Southern California Association of Governments (SCAG) 2008 Regional Transportation Plan (RTP).

Chapter 2. Project Description

The project is located in Orange County on I-405 between SR-73 (PM 9.3) and I-605 (PM 24.2). The project covers a distance of approximately 16 miles. Within the limits of the proposed project, I-405 is a controlled-access highway facility with a fenced ROW, separated from crossing traffic, with vehicular access limited to interchanges. Within the project area, I-405 consists of eight to 12 mixed-flow general purpose (GP) lanes and two high-occupancy vehicle (HOV) lanes.

Build Alternatives 1, 2, and 3 and a no Build alternative have been analyzed as part of this noise study. The project limits of the noise analysis for Alternatives 1 and 2 are from south of Euclid Street to the I-605 interchange. There are no changes to the alignment proposed outside of these limits under these alternatives. The project limits of the noise analysis for Alternative 3 are south of Bristol Street including the SR-73 interchange south to Bear Street to the I-605 interchange including I-605 south of Katella Avenue.

2.1. Project Alternatives

2.1.1. Common Design Features of the Build Alternatives

Build Alternatives 1, 2, and 3 would include the following features:

- One GP lane would be added in each direction of I-405 from Euclid Street to the I-605 interchange.
- Travel lanes on the I-405 mainline would be 12-foot-wide, and right side shoulders would be 10-foot-wide.
- Due to the added travel lanes and shoulder widths proposed on the I-405 mainline, the following 16 local street overcrossings and a pedestrian bridge over I-405 within the project limits would require complete replacement to accommodate the additional proposed width of the freeway underneath the bridges:
  - Ward Street
  - Talbert Avenue
  - Brookhurst Street
  - Slater Avenue
  - Bushard Street
  - Warner Avenue
  - Magnolia Street
  - Pedestrian overcrossing near Heil Avenue
  - Newland Street
  - Edinger Avenue
  - McFadden Avenue
  - Bolsa Avenue
  - Goldenwest Street
  - Edwards Street
  - Westminster Boulevard

  - Springdale Street
  - Bolsa Chica Road

- The I-405/Seal Beach Boulevard overcrossing and various freeway-to-freeway connector structures at the I-405/SR-22 and I-405/I-605 interchanges will be replaced as part of the SR-22 West County Connectors Project, which is currently in the construction phase. The new (replacement) Seal Beach Boulevard overcrossing and freeway-to-freeway connectors to be constructed by the SR-22 West County Connectors Project have been designed to consider the future widening of I-405 proposed by Build Alternatives 1, 2, and 3 of the proposed project.
- The Euclid Street/Ellis Avenue undercrossing bridge would be modified and extended.
- Two railroad overheads would be modified and extended.
- Each build alternative would include interchange reconfigurations at Euclid Street, Ellis Avenue, Brookhurst Street, Magnolia Street, Warner Avenue, Beach Boulevard, and Westminster Boulevard.
- Maintenance vehicle pullouts would be included in various locations under each build alternative.

2.1.2. Unique Features of Build Alternatives

2.1.2.1. ALTERNATIVE 1 – ADD ONE GP LANE IN EACH DIRECTION

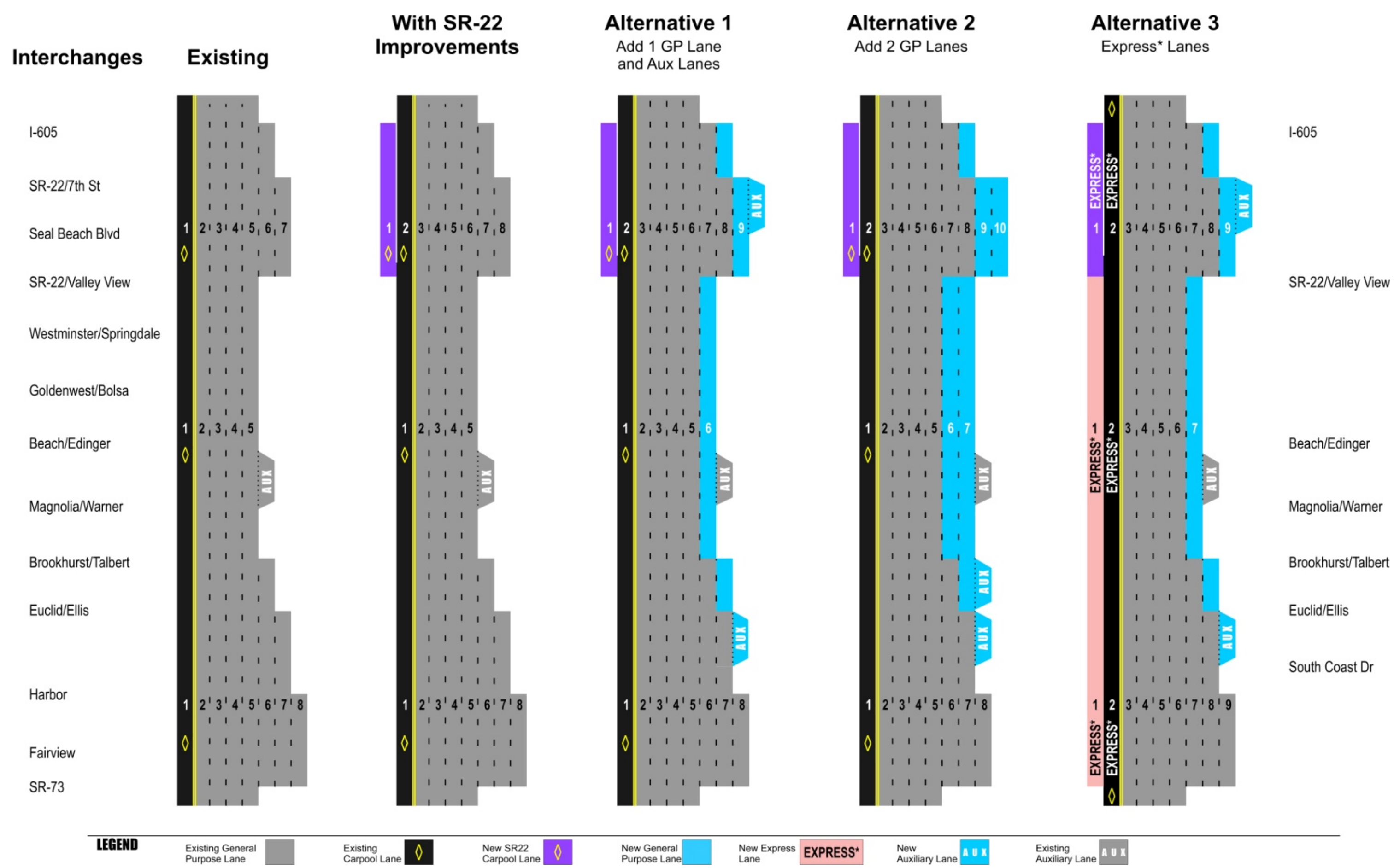
Alternative 1 would add a single GP lane in each direction of I-405 from Euclid Street to the I-605 interchange. Figures 2-1 and 2-2 display the proposed I-405 lane configurations associated with the proposed build alternatives. Alternative 1 would provide a full standard highway cross section, with 12-foot-wide mainline travel lanes as well as 10-foot-wide shoulders on both left (inside) and right (outside) sides in both directions.

Under Alternative 1, auxiliary lanes would be added at various locations to provide efficient merge and diverge operations. The existing northbound auxiliary lane from the Magnolia Street on-ramp to the Beach Boulevard off-ramp would be retained. Additional northbound auxiliary lanes would be provided between ramps at the following locations:

- At the approach of the Euclid Street/Ellis Avenue off-ramp
- From the Seal Beach Boulevard on-ramp to the westbound SR-22/7th Street off-ramp

In the southbound direction, the existing auxiliary lane from the Beach Boulevard on-ramp to the Magnolia Street off-ramp would not be retained. The existing auxiliary lane from the SR-22/7th Street on-ramp to Seal Beach Boulevard would be retained, as would the existing auxiliary lane from the Harbor Boulevard on-ramp to the Fairview off-ramp. An additional auxiliary lane would be included between the Euclid/Ellis on-ramp and the Harbor Boulevard off-ramp

In the northern segment of the project area where SR-22 and I-405 overlap, Alternative 1 would result in a freeway with nine through lanes in each direction. For traffic in the left lanes, including the HOV lanes, signage would be provided far enough upstream to accommodate the required number of lane changes to properly exit the freeway.



Source: Parsons 2010

Figure 2-1. Lane Configurations of Northbound Build Alternatives

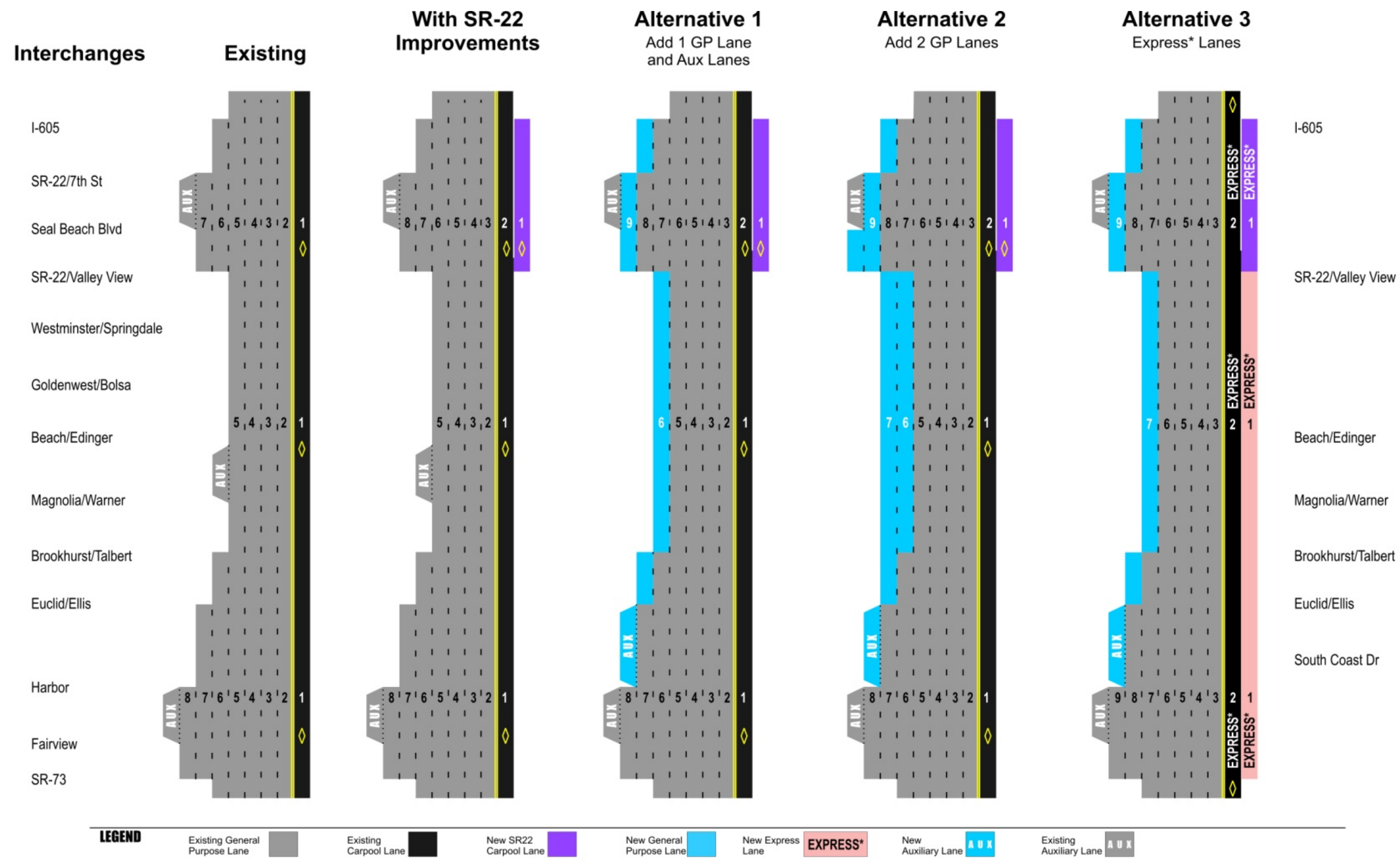


Figure 2-2. Lane Configurations of Southbound Build Alternatives

2.1.2.2. ALTERNATIVE 2 – ADD TWO GP LANES IN EACH DIRECTION

Alternative 2 would add one GP lane in each direction of I-405 from Euclid Street to the I-605 interchange (as in Alternative 1), plus add a second GP lane in the northbound direction from Brookhurst Street to the SR-22/7th Street interchange and a second GP lane in the southbound direction from the Seal Beach Boulevard on-ramp to Brookhurst Street. Figures 2-1 and 2-2 display the proposed I-405 lane configurations associated with the proposed build alternatives.

Alternative 2 would provide a full standard highway cross section, with 12-foot-wide mainline travel lanes and shoulders on the left and right sides in both directions. Right side (outside) shoulders would be 10-foot-wide, while left side (inside) shoulders would have a maximum width of 10 feet with a provision for a widened left shoulder for HOV enforcement areas under consideration.

Alternative 2 would provide continuous access between the HOV and GP lanes. On July 31, 2007, the Department approved a PSR for a separate project (EA 0J440K) to provide continuous ingress and egress from the HOV lanes on the entire length of I-405 in Orange County. This separate project has not yet been programmed or funded; however, the proposed continuous access would be implemented as part of Alternative 2 of the proposed project for the segment of I-405 between Euclid Street and I-605.

Under Alternative 2, auxiliary lanes would be added at various locations to provide efficient merge and diverge operations. In the northbound direction, the existing auxiliary lane from the Magnolia Street on-ramp to the Beach Boulevard off-ramp would be retained. A northbound auxiliary lane would be provided at the northerly approach to the Euclid/Ellis off-ramp, as well as between the Euclid/Ellis on-ramp and the Brookhurst Street/Magnolia Street off-ramp.

In the southbound direction, the existing auxiliary lane from the Beach Boulevard on-ramp to the Magnolia Street off-ramp would not be retained. The existing auxiliary lane from the SR-22/7th Street on-ramp to Seal Beach Boulevard would be retained, as would the existing auxiliary lane from the Harbor Boulevard on-ramp to the Fairview off-ramp. An additional auxiliary lane would be included between the Euclid/Ellis on-ramp and the Harbor Boulevard off-ramp.

2.1.2.3. ALTERNATIVE 3 – EXPRESS FACILITY

Alternative 3 would add one GP lane in each direction of I-405 from Euclid Street to the I-605 interchange (as in Alternatives 1 and 2), plus add a tolled express lane in each direction of I-405 from SR-73 to I-605. The tolled express lane would be placed beside the existing HOV lane in each direction. The existing HOV lanes and new toll lanes would be managed jointly as an Express Lane Facility with two lanes in each direction. Figures 2-1 and 2-2 display the proposed I-405 lane configurations associated with the proposed build alternatives

Alternative 3 would provide a full standard highway cross section, with 12-foot-wide mainline travel lanes and shoulders on the left and right sides in both directions. Right side (outside) shoulders would be 10-foot-wide, while left side (inside) shoulders would have a maximum width of 10 feet with a provision for a widened left shoulder for enforcement areas under consideration. The joint HOV/toll lane Express Lane Facility would be separated from the GP lanes by a 1 to 4 feet buffer.

Under Alternative 3, auxiliary lanes would be added at various locations to provide efficient merge and diverge operations. The existing auxiliary lane from the Magnolia Street on-ramp to the Beach Boulevard off-ramp would be retained. Additional northbound auxiliary lanes would be provided at the northerly approach to the Euclid/Ellis off-ramp, and between the Seal Beach Boulevard on-ramp and the SR-22/7th Street off-ramp.

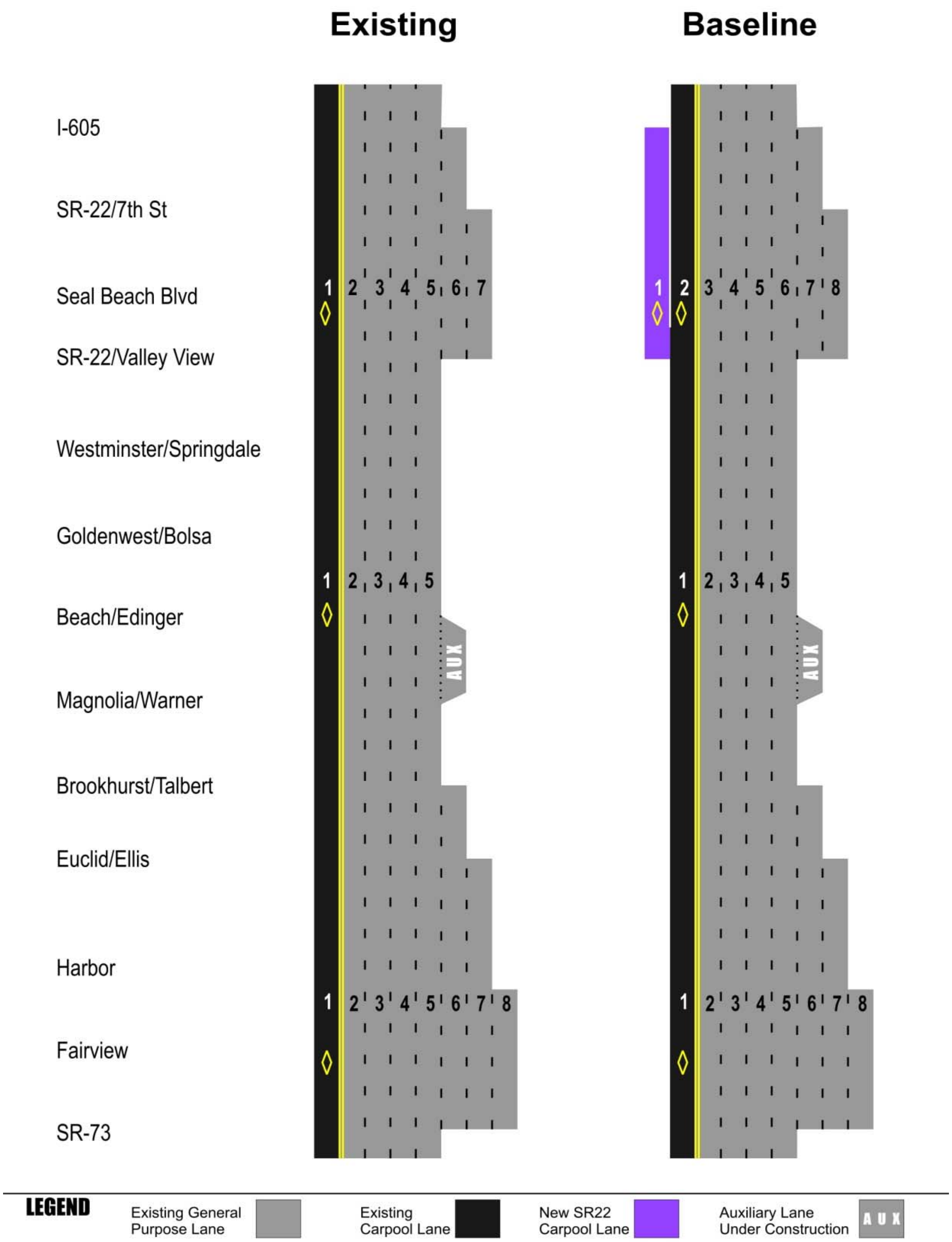
In the southbound direction, the existing auxiliary lane from the Beach Boulevard on-ramp to the Magnolia Street off-ramp would not be retained. The existing auxiliary lane from the SR-22/7th Street on-ramp to Seal Beach Boulevard would be retained, as would the existing auxiliary lane from the Harbor Boulevard on-ramp to the Fairview off-ramp. An additional auxiliary lane would be included between the Euclid/Ellis on-ramp and the Harbor Boulevard off-ramp.

2.1.3. No Build (No Action) Alternative

The No Build Alternative provides a "baseline" for comparing impacts associated with the build alternatives because environmental review must consider the effects of not implementing the proposed project. The Project Baseline conditions under the No Build Alternative would provide no additional lanes or interchange improvements to the I-405 corridor. The project area would continue to operate with no additional improvements and would not achieve the project's stated purpose and need.

Compared to the existing condition, the future project baseline assumed under the No Build Alternative includes the future completion of the SR-22 West County Connectors Project.

Figure 2-3 displays the I-405 lane configuration under existing conditions and future project baseline conditions associated with the No Build Alternative.



Source: Parsons 2010

Figure 2-3. I-405 Lane Configuration – Existing and Future Project Baseline Conditions

Chapter 3. Fundamentals of Traffic Noise

The following is a brief discussion of fundamental traffic noise concepts. For a detailed discussion, please refer to Caltrans' Technical Noise Supplement (TeNS) (Caltrans, 2009), a technical supplement to the Protocol, that is available on the Caltrans Web site (http://www.dot.ca.gov/hq/env/noise/pub/tens_complete.pdf).

3.1. Sound, Noise, and Acoustics

Sound can be described as the mechanical energy of a vibrating object transmitted by pressure waves through a liquid or gaseous medium (e.g., air) to a hearing organ, such as a human ear. Noise is defined as loud, unexpected, or annoying sound.

In the science of acoustics, the fundamental model consists of a sound (or noise) source, a receiver, and the propagation path between the two. The loudness of the noise source and obstructions or atmospheric factors that are affecting the propagation path to the receiver determine the sound level and characteristics of the noise perceived by the receiver. The field of acoustics deals primarily with the propagation and control of sound.

3.2. Frequency

Continuous sound can be described by frequency (pitch) and amplitude (loudness). A low-frequency sound is perceived as low in pitch. Frequency is expressed in terms of cycles per second, or Hertz (Hz) (e.g., a frequency of 250 cycles per second is referred to as 250 Hz). High frequencies are sometimes more conveniently expressed in kilohertz (kHz), or thousands of Hertz. The audible frequency range for humans is generally between 20 Hz and 20,000 Hz.

3.3. Sound Pressure Levels and Decibels

The amplitude of pressure waves generated by a sound source determines the loudness of that source. Sound pressure amplitude is measured in micro-Pascals (µPa). One µPa is approximately one hundred billionth (0.00000000001) of normal atmospheric pressure. Sound pressure amplitudes for different kinds of noise environments can range from less than 100 to 100,000,000 µPa. Because of this huge range of values, sound is rarely expressed in terms of µPa. Instead, a logarithmic scale is used to describe sound pressure level (SPL) in terms of decibels (dB). The threshold of hearing for young people is about 0 dB, which corresponds to 20 µPa.

3.4. Addition of Decibels

Because decibels are logarithmic units, SPL cannot be added or subtracted through ordinary arithmetic. Under the decibel scale, a doubling of sound energy corresponds to a 3-dB increase. In other words, when two identical sources are each producing sound of the same loudness, the resulting sound level at a given distance would be 3 dB higher than one source under the same conditions. For example, if one automobile produces an SPL of 70 dB when it passes an observer, two cars passing simultaneously would not produce 140 dB—rather, they would combine to produce 73 dB. Under the decibel scale, three sources of equal loudness together produce a sound level 5 dB louder than one source.

3.5. A-Weighted Decibels

The decibel scale alone does not adequately characterize how humans perceive noise. The dominant frequencies of a sound have a substantial effect on the human response to that sound. Although the intensity (energy per unit area) of the sound is a purely physical quantity, the loudness or human response is determined by the characteristics of the human ear.

Human hearing is limited in the range of audible frequencies as well as in the way it perceives the SPL in that range. In general, people are most sensitive to the frequency range of 1,000–8,000 Hz, and perceive sounds within that range better than sounds of the same amplitude in higher or lower frequencies. To approximate the response of the human ear, sound levels of individual frequency bands are weighted, depending on the human sensitivity to those frequencies. Then, an “A-weighted” sound level (expressed in units of dBA) can be computed based on this information.

The A-weighting network approximates the frequency response of the average young ear when listening to most ordinary sounds. When people make judgments of the relative loudness or annoyance of a sound, their judgments correlate well with the A-weighted levels of those sounds. Other weighting networks have been devised to address high noise levels or other special problems (e.g., B-, C-, and D-scales), but these scales are rarely used in conjunction with highway-traffic noise. Noise levels for traffic noise reports are typically reported in terms of A-weighted decibels or dBA. Table 3-1 describes typical A-weighted noise levels for various noise sources.

3.6. Human Response to Changes in Noise Levels

As discussed above, doubling sound energy results in a 3 dB increase in sound. However, given a sound level change measured with precise instrumentation, the subjective human perception of a doubling of loudness will usually be different than what is measured.

Under controlled conditions in an acoustical laboratory, the trained, healthy human ear is able to discern 1-dB changes in sound levels, when exposed to steady, single-frequency (“pure-tone”) signals in the mid-frequency (1,000 Hz–8,000 Hz) range. In typical noisy environments, changes in noise of 1 to 2 dB are generally not perceptible. However, it is widely accepted that people are able to begin to detect sound level increases of 3 dB in typical noisy environments. Further, a 5 dB increase is generally perceived as a distinctly noticeable increase, and a 10 dB increase is generally perceived as a doubling of loudness. Therefore, a doubling of sound energy (e.g., doubling the volume of traffic on a highway) that would result in a 3 dB increase in sound, would generally be perceived as detectable by the average person.

Table 3-1. Typical A-Weighted Noise Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	— 110 —	Rock band
Jet fly-over at 1000 feet		
	— 100 —	
Gas lawn mower at 3 feet		
	— 90 —	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	— 80 —	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	**— 70 —**	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	**— 60 —**	
		Large business office
Quiet urban daytime	**— 50 —**	Dishwasher next room
Quiet urban nighttime	**— 40 —**	Theater, large conference room (background)
Quiet suburban nighttime		
	— 30 —	Library
Quiet rural nighttime		Bedroom at night, concert
	— 20 —	
		Broadcast/recording studio
	— 10 —	
Lowest threshold of human hearing	**— 0 —**	Lowest threshold of human hearing

Source: Caltrans, 2009.

3.7. Noise Descriptors

Noise in our daily environment fluctuates over time. Some fluctuations are minor, but some are substantial. Some noise levels occur in regular patterns, but others are random. Some noise levels fluctuate rapidly, but others slowly. Some noise levels vary widely, but others are relatively constant. Various noise descriptors have been developed to describe time-varying noise levels. The following are the noise descriptors most commonly used in traffic noise analysis:

- **Equivalent Sound Level (L_{eq}):** L_{eq} represents an average of the sound energy occurring over a specified period. In effect, L_{eq} is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The 1-hour A-weighted equivalent sound level (L_{eq}[h]) is the energy average of A-weighted sound levels occurring during a one-hour period, and is the basis for noise abatement criteria (NAC) used by Caltrans and FHWA.

- **Percentile-Exceeded Sound Level (L_n):** L_n represents the sound level exceeded for a given percentage of a specified period (e.g., L_{10} is the sound level exceeded 10% of the time, and L_{90} is the sound level exceeded 90% of the time).

- **Maximum Sound Level (L_{max}):** L_{max} is the highest instantaneous sound level measured during a specified period.

- **Day-Night Level (L_{dn}):** L_{dn} is the energy average of A-weighted sound levels occurring over a 24-hour period, with a 10 dB penalty applied to A-weighted sound levels occurring during nighttime hours between 10 p.m. and 7 a.m.

- **Community Noise Equivalent Level (CNEL):** Similar to L_{dn}, CNEL is the energy average of the A-weighted sound levels occurring over a 24-hour period, with a 10 dB penalty applied to A-weighted sound levels occurring during the nighttime hours between 10 p.m. and 7 a.m., and a 5 dB penalty applied to the A-weighted sound levels occurring during evening hours between 7 p.m. and 10 p.m.

3.8. Sound Propagation

When sound propagates over a distance, it changes in level and frequency content. The manner in which noise reduces with distance depends on the following factors.

3.8.1. Geometric Spreading

Sound from a localized source (i.e., a point source) propagates uniformly outward in a spherical pattern. The sound level attenuates (or decreases) at a rate of 6 decibels for each doubling of distance from a point source. Highways consist of several localized noise sources on a defined path, and hence can be treated as a line source, which approximates the effect of several point sources. Noise from a line source propagates outward in a cylindrical pattern, often referred to as cylindrical spreading. Sound levels attenuate at a rate of 3 decibels for each doubling of distance from a line source.

3.8.2. Ground Absorption

The propagation path of noise from a highway to a receiver is usually very close to the ground. Noise attenuation from ground absorption and reflective-wave canceling adds to the attenuation associated with geometric spreading. Traditionally, the excess attenuation has also been expressed in terms of attenuation per doubling of distance. This approximation is usually sufficiently accurate for distances of less than 200 feet. For acoustically hard sites (i.e., sites with a reflective surface between the source and the receiver, such as a parking lot or body of water,), no excess ground attenuation is assumed. For acoustically absorptive or soft sites (i.e., those sites with an absorptive ground surface between the source and the receiver, such as soft dirt, grass, or scattered bushes and trees), an excess ground-attenuation value of 1.5 decibels per doubling of distance is normally assumed. When added to the cylindrical spreading, the excess ground attenuation results in an overall drop-off rate of 4.5 decibels per doubling of distance for a line source.

3.8.3. Atmospheric Effects

Receivers located downwind from a source can be exposed to increased noise levels relative to calm conditions, whereas locations upwind can have lowered noise levels. Sound levels can be increased at large distances (e.g., more than 500 feet) from the highway due to atmospheric temperature inversion (i.e., increasing temperature with elevation). Other factors such as air temperature, humidity, and turbulence can also have significant effects.

3.8.4. Shielding by Natural or Human-Made Features

A large object or barrier in the path between a noise source and a receiver can substantially attenuate noise levels at the receiver. The amount of attenuation provided by shielding depends on the size of the object and the frequency content of the noise source. Natural terrain features (e.g., hills and dense woods) and human-made features (e.g., buildings and walls) can substantially reduce noise levels. Walls are often constructed between a source and a receiver specifically to reduce noise. A barrier that breaks the line of sight between a source and a receiver will typically result in at least 5 dB of noise reduction. Taller barriers provide increased noise reduction. Heavy vegetation between the highway and receiver could provide additional noise reduction.

Chapter 4. Federal Regulations and State Policies

This report focuses on the requirements of Title 23 CFR 772, as discussed below.

4.1. Federal Regulations

4.1.1. Title 23 CFR 772

Title 23 CFR 772 provides procedures for preparing operational and construction noise studies and evaluating noise abatement considered for federal and federal-aid highway projects. Under Title 23 CFR 772.7, projects are categorized as either Type I or Type II projects. FHWA defines a Type I project as a proposed federal or federal-aid highway project for the construction of a highway on a new location, or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment, or increases the number of through-traffic lanes. A Type II project is a noise barrier retrofit project that involves no changes to highway capacity or alignment.

Type I projects include those that create a completely new noise source, as well as those that increase the volume or speed of traffic or move the traffic closer to a receiver. Type I projects include the addition of an interchange, ramp, auxiliary lane, or truck-climbing lane to an existing highway, or the widening an existing ramp by a full lane width for its entire length. Projects unrelated to increased noise levels, such as striping, lighting, signing, and landscaping projects, are not considered Type I projects.

Under Title 23 CFR 772.11, noise abatement must be considered for Type I projects if the project is predicted to result in a traffic noise impact. In such cases, Title 23 CFR 772 requires that the project sponsor "consider" noise abatement before adoption of the final NEPA document. This process involves identification of noise abatement measures that are reasonable, feasible, and likely to be incorporated into the project, and of noise impacts for which no apparent solution is available.

Traffic noise impacts, as defined in Title 23 CFR 772.5, occur when the predicted noise level in the design year approaches or exceeds the Noise Abatement Criteria (NAC) specified in Title 23 CFR 772, or a predicted noise level substantially exceeds the existing noise level (a "substantial" noise increase). Title 23 CFR 772 does not specifically define the terms "substantial increase" or "approach"; these criteria are defined in the Protocol, as described below. Table 4-1summarizes NAC corresponding to various land use activity categories. Activity categories and related traffic noise impacts are determined based on the actual land use in a given area.

Table 4-1. Activity Categories and Noise Abatement Criteria

Activity Category	NAC, Hourly A-Weighted Noise Level (dBA-L_{eq}[h])	Description of Activities
A	57 Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose
B	67 Exterior	Picnic areas, recreation areas, playgrounds, active sport areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals
C	72 Exterior	Developed lands, properties, or activities not included in categories A or B above
D	—	Undeveloped lands
E	52 Interior	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums

Source: 23 CFR Part 772, 2010

In identifying noise impacts, primary consideration is given to exterior areas of frequent human use. In situations where there are no exterior activity areas, or where the exterior activities occur far from the roadway or physically shielded in a manner that prevents an impact on exterior activities, the interior criterion (Activity Category E) is used as the basis for determining a noise impact.

4.2. State Regulations and Policies

4.2.1. Traffic Noise Analysis Protocol for New Highway Construction and Reconstruction Projects

The Protocol specifies the policies, procedures, and practices to be used by agencies that sponsor new construction or reconstruction of federal or federal-aid highway projects. The NAC specified in the Protocol are the same as those specified in Title 23 CFR 772. The Protocol defines a noise increase as substantial when the predicted noise levels with project implementation exceed existing noise levels by 12 dB. The Protocol also states that a sound level is considered to approach an NAC level when the sound level is within 1 dB of the NAC identified in Title 23 CFR 772 (e.g., 66 dBA is considered to approach the NAC of 67 dBA, but 65 dBA is not).

The TeNS to the Protocol provides detailed technical guidance for the evaluation of highway traffic noise. This includes field measurement methods, noise modeling methods, and report preparation guidance.

4.2.2. Section 216 of the California Streets and Highways Code

Section 216 of the California Streets and Highways Code relates to the noise effects of a proposed freeway project on public and private elementary and secondary schools. Under this code, a noise impact occurs if, as a result of a proposed freeway project, noise levels exceed an L_{eq}(h) of 52 dBA in the interior of public or private elementary or secondary classrooms, libraries, multipurpose rooms, or spaces. This requirement does not replace the “approach or exceed” NAC criterion for FHWA Activity Category E for classroom interiors, but it is a requirement that must be addressed in addition to the requirements of Title 23 CFR 772.

If a project results in a noise impact under this code, noise abatement must be provided to reduce classroom noise to a level that is at or below an $L_{eq}(h)$ of 52 dBA. If the noise levels generated from freeway and non-freeway sources exceed an $L_{eq}(h)$ of 52 dBA prior to the construction of the proposed freeway project, then noise abatement must be provided to reduce the noise to the level that existed prior to construction of the project.

Chapter 5. Study Methods and Procedures

5.1. Methods for Identifying Land Uses and Selecting Noise Measurement and Modeling Locations

An in depth field investigation was conducted to identify frequent outdoor use areas that could be subject to traffic noise impacts and to consider the physical setting of the freeway alignment relative to those areas. Land uses in the project area were categorized as defined in the Activity Category of Table 4-1. As stated in the Protocol, noise abatement is only considered for areas of frequent human use that would benefit from a lowered noise level. Accordingly, this impact analysis focuses on locations with defined outdoor activity areas, such as residential backyards and common use areas at multi-family residences. A few temporary lodging facilities such as motels and inns are also located within the project study area. Because they currently have frequent human use areas such as a pool or common area where people congregate for 1 hour or more on a daily basis, those areas were also evaluated for exterior noise impacts. Figures in Appendix A indicate the locations of relevant land use types within the study corridor.

Multiple outdoor noise measurements were taken throughout the project study corridor in order to evaluate existing noise levels and to calibrate the TNM 2.5 computer noise model. Specific measurement sites were chosen to be representative of receiver sites with similar topography, orientation to the highway, exposure angles, etc. with respect to frequent outdoor use areas adjacent to I-405. Locations that are expected to receive the greatest traffic noise impacts, such as the first row of houses from the highway, were generally chosen. However, noise measurements at second row residences were also conducted in several areas.

Noise measurements were mainly conducted in frequent outdoor human-use areas along the project alignment primarily in backyard locations. Where permits to enter were not obtained, short-term measurements were conducted within a nearby sidewalk or cul-de-sac location determined to be acoustically representative of the actual frequent use area.

5.2. Field Measurement Procedures

Noise measurements were conducted at selected locations to evaluate the existing noise environment. Noise measurements were conducted in conformance with the TeNS and with the guidelines outlined in the FHWA's "Measuring of Highway Related Noise," FHWA-DP-96-046. The following is a brief description of the measurement procedures used for this project:

- Microphones were primarily placed approximately 5 feet above the ground and were positioned more than 10 feet from any wall or building to prevent reflections or unrepresentative shielding of the noise. In one location this was not possible due to the small outdoor use areas.
- Sound level meters were calibrated before and after each set of measurements.
- Following the calibration of equipment, a windscreen was placed over the microphone.
- Frequency weighting was set on "A", and the slow detector response was selected.

- Results of the short-term noise measurements were recorded on data sheets in the field. Long-term measured data were downloaded to the computer for tabulation and graphing.
- During the short-term noise measurements, any noise contaminations such as barking dogs, local traffic, etc. were noted. Measurements were repeated if it was determined that there were non-traffic related noise contributions which affected the results. Calibration measurements were free of contaminating sounds. Whenever possible, measurements that were determined to be unreliable due to transient contaminants were repeated at the offending site.
- Traffic was counted for model calibration measurements. Vehicle types were separated into three vehicle groups: automobiles, medium trucks (2-axle with 6-wheels but not including dually pick-up trucks), and heavy trucks (3 or more axle vehicles). Average traffic speeds were measured using a radar gun or by driving on the roadways before and after a calibration measurement.
- Wind speed, temperature, humidity, and sky conditions were observed and documented during the short-term noise measurements.

The instruments used for the noise measurements included the following:

- Sound Level Meters – Larson Davis models 812, 820, and 870; Brüel & Kjær models 2238 and 2250.
- Microphone Systems:
    - Larson Davis 812 and 820 Systems – Larson Davis model PRM 828 microphone preamp; Larson Davis model 2560, ½-inch pressure microphone.
    - Larson Davis 870 System – Larson Davis model 900B microphone preamps; Larson Davis model 2559, ½-inch pressure microphone.
    - Brüel & Kjær 2238 System – Brüel & Kjær model ZC-0030 microphone preamp; Brüel & Kjær model 4188, ½-inch pressure microphone.
    - Brüel & Kjær 2250 System – Brüel & Kjær model ZC-0032 microphone preamp; Brüel & Kjær model 4189, ½-inch pressure microphone.
- Acoustic Field Calibrators:
    - Larson Davis Systems – Larson Davis model CAL 200 and CA250 constant pressure microphone calibrators.
    - Brüel & Kjær Systems – Brüel & Kjær 4231 constant pressure microphone calibrators.
- Microphone cables; 4-inch diameter windscreens; and tripods.
- Wind Monitor/Temperature and Humidity Gauge – Kestrel 3000 Pocket Weather Meter.
- Stationary Handheld Traffic Radar Detector – Astro Products Phantom Radar Detector.

Appendix F contains the calibration records for the sound level meters, microphone systems, and acoustical field calibrators.

5.2.1. Short-Term Measurements

Short-term monitoring was conducted at 61 locations in June of 2010 and one additional location in August of 2010 using Larson-Davis and Brüel & Kjær Precision Type 1 sound level meters. Measurements were taken at20-minute durations at each site. During the short-term measurements, field staff attended each meter to identify and log the dominant noise sources. The calibration of the meter was checked before and after the measurement using Larson-Davis and Brüel & Kjær calibrators. Short-term monitoring was mostly conducted at Activity Category B land uses. The short-term measurement locations are identified in Appendix A.

Temperature, wind speed, and humidity were recorded manually during the short-term monitoring session using a Kestrel 3000 portable weather station. During the short-term measurements, wind speeds typically ranged from 0 to 4 mile per hour (mph). Temperatures ranged from 66 to 81°F, with relative humidity typically 50–80%.

Traffic on I-405 was recorded using a camcorder during several of the measurements; then, it was later classified and counted for the calibration of the prediction software. Vehicles were classified as automobiles, medium-duty trucks, or heavy-duty trucks. An automobile was defined as a vehicle with two axles and four tires that are designed primarily to carry passengers. Small vans and light trucks were included in this category. Medium-duty trucks included all cargo vehicles with two axles and six tires. Heavy-duty trucks included all vehicles with three or more axles. Heavy trucks appeared to be moving at a slightly lower speed than passenger cars and medium trucks.

5.2.2. Long -Term Measurements

Long-term monitoring was conducted at 30 locations using a Larson-Davis Type 1 sound level meters. The purpose of these measurements was to identify variations in sound levels throughout the day. The long-term sound level data was collected for a 24-hour period. Long-term monitoring locations are shown on figures included in Appendix A.

5.3. Prediction Methods

The FHWA Traffic Noise Model Version 2.5 (TNM 2.5) was used for the noise computations (FHWA, 2004). TNM 2.5 inputs are based on a three-dimensional grid created for the study area to be modeled. All roadway, barrier, terrain lines, and receiver points are defined by their x, y, and z coordinates. Roadways, terrain lines, and barriers are coded into TNM 2.5 as line segments defined by their end points. Receivers, defined as single points, are typically located at frequent outdoor use areas such as residences, schools, and recreational areas. In general, receivers are modeled at a height of 5 feet above ground elevation. Appendix B lists the addresses and year built of modeled noise receivers.

In order to determine the noise levels generated by traffic, the TNM 2.5 computer program requires inputs of traffic volumes, speeds, and vehicle types. Three vehicle types were input into the model: cars, medium trucks, and heavy trucks. The propagation path between the source and receiver is modeled in TNM 2.5 by specifying special terrain features, rows of houses or building structures, and existing walls. Propagation of noise can be further specified by selecting ground types such as hard soil, loose soil, pavement, lawn, and field grass. The lawn option was chosen as the overall ground type for this study, because the grounds between receivers and I-405 are generally vegetated. All other natural obstructions, such as cuts and fills that could affect the future predicted noise levels were also included in the input files.

Traffic noise is a function of traffic type, volume, and speed. Generally, noise increases with increased speed and with higher volumes of traffic. However, at much higher volumes, travel speed decreases (stop and go conditions), so the worst-case noise levels are experienced when there is an optimum balance between the volume and speed. For purposes of determining noise impacts, the worst-case traffic noise occurs when traffic is operating under Level-of-Service (LOS) C conditions. Under these conditions, traffic is heavy, but remains free flowing. The volume on any lane is a function of its traffic type (main lane, HOV lane, and ramp) for LOS C conditions. Appendix C presents the comprehensive listing of the future traffic volumes and traffic distribution per direction of travel used for the noise analysis for the existing, future No Build, and Build Alternatives.

Truck percentages relative to the total traffic volume were obtained from *Annual Average Daily Truck Traffic on the California Highway System* in the Caltrans web site (Caltrans, 2009). The future truck traffic percentages for use in this analysis are shown in Appendix C for northbound and southbound mainline lanes and modeled ramps. It was assumed that the truck percentages in the future would remain similar to the existing conditions. Furthermore, because land use along the proposed project alignment is predominantly residential, heavy truck percentages on ramps and exit lanes are assumed to be half that of the mainline percentages. It is assumed that only a portion of the heavy trucks will enter and exit the freeway in this area except at the Harbor Boulevard ramps where the surrounding area is largely commercial.

There are generally four to five general lanes of travel in each direction. Typically, heavy trucks do not travel in the inner or “fast” lanes; thus, heavy truck traffic volumes were modeled only in the outer two lanes. In the modeling of the Build Alternative conditions, it was assumed that heavy trucks would not travel in the HOV lane. The LOS C volumes of general traffic lanes and HOV/auxiliary lanes/connectors were assumed to be 1,850 and 1,500 vph/lane, respectively. For modeled freeway ramps, traffic volumes were based on modeled future demand volumes (Traffic Report, 2010) or 1,000 vph/lane, whichever was lower.

TNM 2.5 was used to compare measured traffic noise levels to modeled noise levels at field measurement locations to validate the accuracy of the model. Traffic volumes counted during each measurement period were normalized to 1-hour volumes. These normalized volumes were assigned to the corresponding project area roadways to simulate the noise source strength at the roadways during the actual measurement periods. Modeled and corresponding measured sound levels were then compared to determine the accuracy of the model and if additional calibration of the model was necessary.

5.4. Methods for Identifying Traffic Noise Impacts and Consideration of Abatement

Traffic noise impacts are considered to occur at receiver locations where predicted design-year traffic noise levels are at least 12 dB greater than existing noise levels, or where predicted design year traffic noise levels approach or exceed the NAC for the applicable activity category. Where traffic noise impacts are identified, noise abatement must be considered for reasonableness and feasibility as required by Title 23 CFR 772 and the Protocol.

According to the Protocol, abatement measures are considered acoustically feasible if a minimum noise reduction of 5 dB at receiver locations is predicted with implementation of the abatement measures. In addition, barriers should be designed to intercept the line-of-sight from the exhaust stack of a truck to the first tier of receivers, as suggested by the Highway Design Manual, Chapter 1100. Other factors that affect feasibility include topography, access requirements for driveways and ramps, presence of local cross streets, utility conflicts, train crossings, and safety considerations. The overall reasonableness of noise abatement is determined by considering factors such as cost; absolute predicted noise levels; predicted future increase in noise levels; expected noise abatement benefits; build date of surrounding residential development along the highway; environmental impacts of abatement construction; opinions of affected residents; input from the public and local agencies; and social, legal, and technological factors.

The Protocol defines the procedure for assessing reasonableness of noise barriers from a cost perspective. A cost-per-residence allowance is calculated for each benefited residence (i.e., residences that receive at least 5 dB of noise reduction from a noise barrier). The 2009 base allowance of $31,000 is used for this project. Additional allowance dollars are added to the base allowance based on absolute noise levels, the increase in noise levels resulting from the project, achievable noise reduction, and the date of building construction in the area. Total allowances are calculated by multiplying the cost-per-residence by the number of benefited residences.

Chapter 6. Existing Noise Environment

6.1. Existing Land Uses

A field investigation was conducted to identify land uses that could be subject to traffic noise impacts from the proposed project. Single-family residences, multi-family residences, schools, parks, religious institutions, and hotel/motels were identified as Activity Category B land uses with outdoor frequent use areas along the proposed project alignment. Numerous commercial uses in the area are Activity Category C land uses with no outdoor frequent use areas.

The dominant land uses within the project study area include low and medium density residential (single- and multiple-family), commercial (neighborhood and regional), and light industrial (general manufacturing). Topography along the corridor is relatively flat where the majority of local traffic roadways cross over I-405. There are also two train tracks that I-405 cross over; the first runs north/south between McFadden and Bolsa Avenues and the second runs east/west between Goldenwest and Edwards Streets. Traffic on I-405 is the dominant source of noise in the study area. Additionally, there are several drainage structures that follow the corridor and/or cross under I-405 including the Santa Ana River which I-405 crosses over.

The project corridor has been divided into six segments for the noise study based upon major local interchanges. The following describes groups of neighborhoods in each segment:

Segment 1 – I-405 South of Bristol Street to Euclid Street, SR-73 South to Bear Street: The land uses along I-405 in this area include commercial development such as South Coast Plaza Mall, (Activity Category C) as well as single- and multi-family residences, three neighborhood parks, and a hotel (Activity Category B). There is also a patch of farm land on the northbound side of I-405 between Fairview Road and Harbor Boulevard. The single-family residences and parks are largely on the southbound side of I-405 except between Bear Street and Fairview Road where there are both single-and multi-family residences. Located along SR-73 between Bear Street and the I-405 interchange are single-family residences. Throughout this segment, soundwalls and masonry property walls provide freeway traffic noise reduction to the majority of residences and other Activity Category B land uses.

Segment 2 - Euclid Street to Magnolia Street: Between these two interchanges the adjacent areas on both sides of the corridor are predominantly residential, including single-family residences, townhouses, and apartments, as well as outdoor use areas of Fountain Valley High School, a pre-school associated with Huntington Baptist Church, Los Alamos Park, and outdoor pool areas of Courtyard Inn and Residence Inn. The majority of residential developments have masonry property walls as well as existing soundwalls. At the south end of this segment between Euclid and Ward Streets, the surrounding areas are commercial.

Segment 3 - Magnolia Street to Bolsa Avenue / Goldenwest Street: This area along the project corridor is largely residential including single-family residences, apartment complexes, a mobile home park, and also includes Pleasant View and College Parks. Throughout this area, existing property walls and/or soundwalls protect most of the outdoor use areas from freeway traffic noise.

Segment 4 - Bolsa Avenue / Goldenwest Street to SR-22 / Valley View Street, SR-22 East to Springdale Street: In this segment of the highway, the adjacent land use is predominantly residential with pockets of commercial including the Westminster Mall. The land uses along I-405 include single-family residences, four schools, three neighborhood parks, an outdoor pool area of Motel 6, and a mobile home park. Land uses along SR-22 include single-family residences and two mobile home parks as well as an apartment complex without any frequent outdoor use areas exposed to traffic noise. Existing masonry property walls and soundwalls provide shielding from freeway traffic noise at the majority of residential land uses.

Segment 5 - Valley View Street to Seal Beach Boulevard: Activity Category B land use areas in this segment along I-405 consist of single-family residences, Shapell Park, Blue Bell Park, Seal Beach Tennis Court Center, and Sunrise Senior Living. Other land uses along this segment of the corridor include the Old Ranch Golf Practice Range and the Seal Beach Naval Weapons Station along the eastbound side. Existing soundwalls and masonry property walls provide freeway traffic noise reduction at Activity Category B land uses.

Segment 6 - Seal Beach Boulevard to I-605, I-605 North to South of Katella Avenue: Along I-405 in this segment, the predominant Activity Category B land use is single-family residential and multi-family residential of Leisure World Retirement Community. Other Category B land use areas include a gazebo area of First Christian Church of Leisure World. Also located in this area is the Leisure World Library which is an Activity Category E land use. The residential land uses are protected from freeway traffic noise by existing soundwalls and property walls.

6.2. Noise Measurement Results

The existing noise environment in the project area is characterized in the following sections based on short-term and long-term noise monitoring that was conducted.

6.2.1. Short-term Monitoring

Short-term measurements were conducted at a total of 61 measurement sites in June of 2010 for a duration of 20 minutes each. An additional short-term measurement was conducted in August of 2010 for noise model calibration purposes. Table 6-1 summarizes the short-term measurement results. The primary objectives of the short-term measurements were to evaluate the existing noise environment and calibrate the traffic noise prediction model.

Also included in Table 6-1 are the land use types for each of the measurement sites. Project layout plans in Appendix A presents the measurement locations. Appendix D includes noise measurement data sheets recorded in the field and Appendix E includes the noise measurement site photographs. Appendix F contains the calibration records for the sound level meters, microphone systems, and acoustical field calibrators. Although some noise measurements were conducted at areas that are not considered outdoor frequent use areas such as front yards, sidewalks, or cul-de-sacs, the data collected is acoustically representative of geographically larger areas of frequent use areas. Noise measurements conducted at sidewalks or cul-de-sacs was necessary because permissions to enter (PTEs) could not be obtained at some prospective noise measurement locations.

As summarized in Table 6-1 many measurement sites along the project corridor already approach or exceed the NAC of 67 dBA. Some of the short-term measurements were conducted during time intervals outside of the peak noise hour. These measurements have been adjusted to reflect peak hourly noise levels using the results of the nearby long-term noise measurements. The peak noise hour was determined by a long-term measurement running simultaneously with each short-term measurement. The difference in noise levels between the hour in which the short-term level was recorded and the hour that the actual peak hour level occurred was then applied to each of the short-term levels to adjust it to the peak hour.

6.2.2. Long-Term Monitoring

Long-term measurements were conducted at 30 locations for at least 24 hours using Type 1 sound level meters. The long-term measurements were conducted to observe hourly noise distribution and identify the peak noise hours. Table 6-2 summarizes long-term monitoring results and shows addresses of these monitoring locations. Project layout plans in Appendix A presents the measurement locations. Appendix D includes field survey sheets and hourly Leq graphs and Appendix E includes the site photographs of the noise measurements. Appendix F contains the calibration records for the sound level meters, microphone systems, and acoustical field calibrators.

Table 6-1. Short-Term Noise Measurement Results

Site No.	Street Address, City	Land Use[1]	Noise Abatement Category (Criterion)[2]	Meter Location	Meas. Dates	Start Time	Meas. Leq, dBA[3]	Adjusted Peak-Hour Leq, dBA	Adjusted to Long-Term Site
ST1	13671 Olympic Ave., Costa Mesa	SFR	B (67)	Backyard	06/08/10	13:40	64.6	67.6	LT1
ST1A	3049 Yukon Cir., Costa Mesa	SFR	B (67)	Backyard	06/07/10	11:20	54.4	56.4	LT1A
ST1B	960 Springfield St., Costa Mesa	SFR	B (67)	Sidewalk	06/07/10	12:20	54.1	56.1	LT1B
ST1C [4]	910 Liard Pl., Costa Mesa	SFR	B (67)	Sidewalk	06/07/10	14:00	61.8	62.8	LT1A
ST2	990 Hartford Way, Costa Mesa	SFR	B (67)	Sidewalk	06/07/10	15:20	55.6	56.6	LT1B
ST2A	1052 Concord St., Costa Mesa	SFR	B (67)	Backyard	06/08/10	11:20	57.4	59.4	LT2
ST3	1000 S. Coast Dr., Costa Mesa	MFR	B (67)	Common area	06/09/10	12:20	58.9	60.9	LT3
ST4	Wimbledon Glen Apts., Costa Mesa	MFR	B (67)	Pool area	06/09/10	12:00	58.6	60.6	LT3
ST5	Gisler Park, Costa Mesa	REC	B (67)	Playground	06/09/10	09:20	66.4	68.4	LT4
ST6	1376 Garlingford St., Costa Mesa	SFR	B (67)	Backyard	06/09/10	09:40	57.7	59.7	LT4
ST7	Vagabond Inn, 3205 Harbor Blvd., Costa Mesa	MOT	B (67)	Pool area	06/09/10	16:00	55.6	58.6	LT5
ST8	1630 Iowa St. #D, Costa Mesa	MFR	B (67)	Backyard	06/09/10	17:00	67.6	69.6	LT5
ST9	3342 Nevada Ave., Costa Mesa	SFR	B (67)	Backyard	06/09/10	15:00	60.9	63.9	LT5
ST9A	3324 Wyoming Cir., Costa Mesa	SFR	B (67)	Backyard	06/10/10	10:00	56.3	58.3	LT5
ST10	La Quinta Inn, 1515 S. Coast Dr., Costa Mesa	MOT	B (67)	Pool area	06/09/10	10:40	71.0	72.0	LT3
ST11	10242 Durango River Ct., Fountain Valley	MFR	B (67)	Backyard	06/10/10	13:40	59.1	62.1	LT6

Notes:
1. SFR – Single-family residential; MFR – Multi-family residential; MH – Mobile home; REC – Recreational; SCH – School; MOT – Hotel/Motel.
2. According to Caltrans Traffic Noise Analysis Protocol.
3. All short-term measured noise levels are 20-minutes Leq.
4. Short-term measurement levels were suspicious and have not been included in the noise barrier analysis.

Table 6-1. Short-Term Noise Measurement Results (Cont'd)

Site No.	Street Address, City	Land Use[1]	Noise Abatement Category (Criterion)[2]	Meter Location	Meas. Dates	Start Time	Meas. Leq, dBA[3]	Adjusted Peak-Hour Leq, dBA	Adjusted to Long-Term Site
ST12	10328 La Despensa Ave., Fountain Valley	SFR	B (67)	Backyard	06/10/10	11:20	56.5	56.5	LT7
ST12A	17828 Montezuma Cir., Fountain Valley	SFR	B (67)	Front yard	06/10/10	12:40	60.0	60.0	LT7
ST13	17701 San Rafael St., Fountain Valley	SFR	B (67)	Backyard	06/10/10	12:00	57.5	57.5	LT7
ST14[4]	17820 Toiyabe St., Fountain Valley	SFR	B (67)	Sidewalk	06/10/10	15:40	53.6	57.6	LT8
ST15	Fountain Valley High School, Fountain Valley	SCH	B (67)	Soccer field	06/10/10	16:20	59.2	63.2	LT8
ST16	Huntington Valley Preschool, Fountain Valley	SCH	B (67)	Playground	06/15/10	17:40	64.6	67.6	LT9
ST17	Corte Bella Apts., 9580 El Rey Ave., Fountain Valley	MFR	B (67)	Pool area	06/16/10	17:00	56.7	59.7	LT10
ST17A	Corte Bella Apts., 9580 El Rey Ave., Fountain Valley	MFR	B (67)	Entrance /Garages	06/16/10	16:40	63.9	65.9	LT10
ST18[4]	9197 El Cortez St., Fountain Valley	SFR	B (67)	Backyard	06/15/10	18:20	53.3	55.3	LT10
ST19	Grande Apts., 9350 Emery Ct., Fountain Valley	MFR	B (67)	Patio	06/14/10	10:00	60.4	61.4	LT11
ST20	Archstone Apts., 8945 Riverbend Dr., Huntington Beach	MFR	B (67)	Common area	06/16/10	16:00	51.4	54.4	LT12
ST21	16450 Ross Cr., Westminster	SFR	B (67)	Backyard	06/16/10	13:00	62.8	65.8	LT12

Notes:

1. SFR – Single-family residential; MFR – Multi-family residential; MH – Mobile home; REC – Recreational; SCH – School; MOT – Hotel/Motel.
2. According to Caltrans Traffic Noise Analysis Protocol.
3. All short-term measured noise levels are 20-minutes Leq.
4. Short-term measurement levels were suspicious and have not been included in the noise barrier analysis.

Table 6-1. Short-Term Noise Measurement Results (Cont'd)

Site No.	Street Address, City	Land Use[1]	Noise Abatement Category (Criterion)[2]	Meter Location	Meas. Dates	Start Time	Meas. Leq, dBA[3]	Adjusted Peak-Hour Leq, dBA	Adjusted to Long-Term Site
ST22	Casa Tiempo Apts., 8882 Heil Ave., Westminster	MFR	B (67)	Pool area	06/14/10	16:00	63.9	64.9	LT13
ST23	8541 Universe Ave., Westminster	SFR	B (67)	Sidewalk	06/14/10	12:40	65.6	67.6	LT13
ST24	Huntington Creek Apartments, 8211 San Angelo Dr., Huntington Beach	MFR	B (67)	Common area	06/16/10	15:20	59.8	61.8	LT14
ST25	8172 Crown Ct., Westminster	SFR	B (67)	Backyard	06/14/10	10:20	61.7	62.7	LT13
ST25A	8172 Crown Ct., Westminster	SFR	B (67)	Common area	06/14/10	10:40	60.2	61.2	LT13
ST26	8095 Worthy Dr., Westminster	MFR	B (67)	Pool area	06/14/10	18:00	58.9	59.9	LT13
ST27	53 Maplewood Ln., Westminster	MH	B (67)	Front yard	06/14/10	17:00	62.2	63.2	LT15
ST28	College Park, 15422 Vermont St., Westminster	REC	B (67)	Playground	06/15/10	14:40	60.6	64.6	LT16
ST29	7141 Rutgers Ave., Westminster	MFR	B (67)	Backyard	06/16/10	10:20	61.7	64.7	LT16
ST30	6722 Hazard Ave., Westminster	SFR	B (67)	Sidewalk	06/21/10	15:00	60.1	61.1	LT17
ST31	Buckingham Park, 6502 Homer St., Westminster	REC	B (67)	Playground	06/21/10	16:00	65.8	66.8	LT17
ST32	Hollybrook Apts., 14221 Edwards St., Westminster	MFR	B (67)	Patio	06/22/10	12:00	67.3	68.3	LT18
ST32A	Hollybrook Apts., 14221 Edwards St., Westminster	MFR	B (67)	Common area	06/22/10	12:00	63.1	64.1	LT18
ST33	Motel 6, 6266 Westminster Blvd., Westminster	MOT	B (67)	Pool area	06/22/10	11:20	72.6	72.6	LT18

Notes:
1. SFR – Single-family residential; MFR – Multi-family residential; MH – Mobile home; REC – Recreational; SCH – School; MOT – Hotel/Motel.
2. According to Caltrans Traffic Noise Analysis Protocol.
3. All short-term measured noise levels are 20-minutes Leq.
4. Short-term measurement levels were suspicious and have not been included in the noise barrier analysis.

Table 6-1. Short-Term Noise Measurement Results (Cont'd)

Site No.	Street Address, City	Land Use[1]	Noise Abatement Category (Criterion)[2]	Meter Location	Meas. Dates	Start Time	Meas. Leq, dBA[3]	Adjusted Peak-Hour Leq, dBA	Adjusted to Long-Term Site
ST34[4]	Cascade Park, 14100 Cascade St., Westminster	REC	B (67)	Playground	06/22/10	10:20	65.5	68.5	LT19
ST35	Indian Village Park, 6060 Hefley St., Westminster	REC	B (67)	Playground	06/21/10	10:40	69.2	69.2	LT20
ST35A	5551 Norma Dr., Westminster	SFR	B (67)	Sidewalk	06/21/10	09:20	59.7	59.7	LT20
ST36	13842 Sherwood St., Westminster	SFR	B (67)	Backyard	06/22/10	9:20	62.1	64.1	LT21
ST37	434/435 Via Valencia, Westminster	MH	B (67)	Common area	06/21/10	17:00	66.4	66.4	LT20
ST37A	5842 Anthony Ave., Garden Grove	SFR	B (67)	Backyard	06/24/10	09:00	59.2	62.2	LT20A
ST37B	79 Via Del Norte, Garden Grove	MH	B (67)	Common area	06/24/10	15:40	59.7	60.7	LT20B
ST38	5382 Duncannon Ave., Westminster	SFR	B (67)	Backyard	06/22/10	08:20	63.2	65.2	LT21
ST38A	13131 Buckingham Cir., Westminster	SFR	B (67)	Backyard	06/22/10	10:00	62.7	64.7	LT21
ST39	5232 Chrystal Ave., Garden Grove	SFR	B (67)	Backyard	06/23/10	14:20	61.7	61.7	LT22
ST40	3560 Wisteria St., Seal Beach	SFR	B (67)	Backyard	06/23/10	08:40	59.5	61.5	LT22
ST41	Shapell Park, Seal Beach	REC	B (67)	Playground	06/23/10	08:00	66.7	68.7	LT22
ST41A	3521 Daisy St., Seal Beach	SFR	B (67)	Sidewalk	06/23/10	09:20	66.4	68.4	LT22
ST42	City of Seal Beach Tennis Court, 3501-3579 Aster St., Seal Beach	REC	B (67)	Tennis court	06/23/10	09:20	64.2	66.2	LT22
ST43	276H Northwood Rd., Seal Beach	MFR	B (67)	Front yard	06/23/10	11:40	61.5	63.5	LT24

Notes:
1. SFR – Single-family residential; MFR – Multi-family residential; MH – Mobile home; REC – Recreational; SCH – School; MOT – Hotel/Motel.
2. According to Caltrans Traffic Noise Analysis Protocol.
3. All short-term measured noise levels are 20-minutes Leq.
4. Short-term measurement levels were suspicious and have not been included in the noise barrier analysis.

Table 6-1. Short-Term Noise Measurement Results (Cont'd)

Site No.	Street Address, City	Land Use[1]	Noise Abatement Category (Criterion)[2]	Meter Location	Meas. Dates	Start Time	Meas. Leq, dBA[3]	Adjusted Peak-Hour Leq, dBA	Adjusted to Long-Term Site
ST44	12835 Martha Ann Dr., Los Alamitos	SFR	B (67)	Backyard	06/22/10	16:20	60.4	62.4	LT23
ST45	12311 Martha Ann Dr., Los Alamitos	SFR	B (67)	Backyard	06/23/10	12:40	60.8	62.8	LT25
ST46	11411 Martha Ann Dr., Los Alamitos	SFR	B (67)	Backyard	06/23/10	12:40	63.9	64.9	LT26
CAL18	8832 Savoy Cir., Huntington Beach	SFR	B (67)	Cul-du-sac	08/31/10	12:47	63.9	--	--

Notes:

1. SFR – Single-family residential; MFR – Multi-family residential; MH – Mobile home; REC – Recreational; SCH – School; MOT – Hotel/Motel.
2. According to Caltrans Traffic Noise Analysis Protocol.
3. All short-term measured noise levels are 20-minutes L_{eq}.
4. Short-term measurement levels were suspicious and have not been included in the noise barrier analysis.

Table 6-2. Long-Term Noise Measurement Results

Site No.	Street Address, City	Land Use[1]	Noise Abatement Category (Criterion) [2]	Meter Location	Meas. Dates	Start Time	Measured Peak Hour Leq, dBA
LT1	920 Tanana Pl., Costa Mesa	SFR	B (67)	Backyard	06/07/10	15:40	59
LT1A	3077 Yukon Ave., Costa Mesa	SFR	B (67)	Backyard	06/07/10	11:00	60
LT1B	938 Cheyenne St., Costa Mesa	SFR	B (67)	Backyard	06/07/10	10:20	59
LT2	1142 Charleston St., Costa Mesa	SFR	B (67)	Backyard	06/07/10	15:00	61
LT3	1063 Leandro Ln., Costa Mesa	SFR	B (67)	Backyard	06/8/10	11:40	65
LT4	1288 Londonderry St., Costa Mesa	SFR	B (67)	Backyard	06/8/10	11:00	62
LT5	3334 Maryland Ct., Costa Mesa	SFR	B (67)	Backyard	06/9/10	12:00	68
LT6	18125 Sand Dunes Ct., Fountain Valley	MFR	B (67)	Backyard	06/9/10	16:20	68
LT7	17893 San Rafael St., Fountain Valley	SFR	B (67)	Backyard	06/9/10	16:00	67
LT8	9849 Oscar Cir., Fountain Valley	SFR	B (67)	Backyard	06/9/10	17:20	64
LT9	17231 Buttonwood St., Fountain Valley	SFR	B (67)	Backyard	06/15/10	15:20	65
LT10	9460 Andalusia Ave., Fountain Valley	SFR	B (67)	Backyard	06/15/10	17:20	67
LT11	16841 Daisy Ave, Fountain Valley	SFR	B (67)	Backyard	06/11/10	13:20	66
LT12	8711 Heil Ave., Westminster	SFR	B (67)	Backyard	06/15/10	16:20	64
LT13	16381 Venus St., Westminster	SFR	B (67)	Backyard	06/11/10	13:40	68
LT14	8480 Wells Rd., Westminster	SFR	B (67)	Backyard	06/15/10	14:20	70
LT15	15431 Cascade Ln., Westminster	SFR	B (67)	Backyard	06/11/10	15:00	66
LT16	15272 Vermont St., Westminster	SFR	B (67)	Backyard	06/15/10	14:20	67
LT17	6872 Sowell Ave., Westminster	SFR	B (67)	Backyard	06/21/10	10:20	64
LT18	14151 Wynn St., Westminster	SFR	B (67)	Backyard	06/21/10	11:00	71
LT19	6251 Mahogany Ave., Westminster	SFR	B (67)	Backyard	06/21/10	12:00	70
LT20	5741 Meinhardt Rd., Westminster	SFR	B (67)	Backyard	06/21/10	08:40	68
LT20A	3142 Anthony Ave., Garden Grove	SFR	B (67)	Backyard	06/23/10	17:40	63
LT20B	655 Via Descanso, Garden Grove	SFR	B (67)	Backyard	06/24/10	10:00	60
LT21	5721 Vallecito Ave., Westminster	SFR	B (67)	Backyard	06/21/10	09:40	67

Notes:

1. SFR – Single-family residential; MFR – Multi-family residential.
2. According to Caltrans Traffic Noise Analysis Protocol.

Table 6-2 – Long-Term Noise Measurement Results (Cont'd)

Site No.	Street Address, City	Land Use[1]	Noise Abatement Category (Criterion) [2]	Meter Location	Meas. Dates	Start Time	Measured Peak Hour Leq, dBA
LT22	3520 Camellia St., Seal Beach	SFR	B (67)	Backyard	06/22/10	18:40	68
LT23	3002 Yellowtail Dr., Rossmoor	SFR	B (67)	Backyard	06/22/10	16:00	67
LT24	Leisure World, Seal Beach	MFR	B (67)	Patio	06/23/10	11:40	64
LT25	12621 Martha Ann Dr., Rossmoor	SFR	B (67)	Backyard	06/23/10	11:40	64
LT26	11541 Martha Ann Dr., Rossmoor	SFR	B (67)	Backyard	06/23/10	10:20	65

Notes:
1. SFR – Single-family residential; MFR – Multi-family residential.
2. According to Caltrans Traffic Noise Analysis Protocol.

6.3. Traffic Noise Model Calibration

Noise measurements for the calibration were conducted with simultaneous traffic counts at 31 locations in June 2010 and one additional measurement was conducted in August 2010. These measurements were conducted to calibrate the Traffic Noise Model (TNM 2.5). Concurrent with the measurements, traffic volumes were recorded using a video camera and/or manually counted and traffic speeds were noted. The traffic counts were tabulated according to three vehicle types, including automobiles, medium trucks (2-axle with 6-wheels but not including pick-up trucks), and heavy trucks (3 or more axles). As a general rule, the noise model is considered to be calibrated if the field measured values versus the modeled noise levels (using field collected traffic data) agree within 2 dB of each other. If differences are more than 2 dB, refinement of the noise model is performed until there is agreement between the two values. If after thorough re-evaluation calibration still cannot be achieved due to complex topography or other unusual circumstances, then a calibration constant is added such that the measured versus modeled values agree before any predictions can be made with the model.

Tables 6-3 and 6-4 summarize the calibration results of 32 long- and short-term measurement locations as well as the traffic volumes that were used in the calibration process, respectively. Out of the 32 calibration sites, nine of them had more than a 1-dB difference between measured and modeled noise levels. Furthermore, amongst these nine calibration sites with more than a 1-dB difference, only four calibration sites had more than a 2-dB difference between measured and modeled noise levels. Five calibration factors and one adjustment factor, or "K" factors, have been applied to the noise model results to the areas acoustically represented by the calibration sites. Tables G-1 through G-18 in Appendix G show the "K" factors applied and to which receivers. The following explains possible causes of the differences at the six sites where "K" factors were applied:

- A calibration or "K" factor of -4.0 dB has been applied to the residences that have similar acoustical and geometrical characteristics to Calibration Site 7 (measurement site LT4). These calibration factors are needed to account for the elements that effect sound propagation that are not accounted for in the noise model. This adjustment factor was applied to Receivers R1.57 through R1.62.

- A calibration or "K" factor of +1.5 dB has been applied to the area that has similar acoustical and geometrical characteristics to Calibration Site 12 (measurement site LT7). This calibration factor is applied to increase the modeled No Build noise levels to at least that of the measured noise levels of the area. This adjustment factor was applied to Receivers R2.14 through R2.20, R2.22, R2.24, R2.25, and R2.27.

- The calibration or "K" factors of -3.0 and -2.5 dB has been applied to the areas that have similar acoustical and geometrical characteristics to Calibration Sites 13, 18, and 22 (measurement sites ST13, CAL18, and ST29). These calibration factors are needed to account for the elements that effect sound propagation that are not accounted for in the noise model. The adjustment factor of -3.0 dB was applied to Receivers R2.28, R2.29, and R2.30. The adjustment factor of -2.5 dB was applied to Receivers R3.24 through R3.42 as well as R3.99, R3.99A, R3.100, R100A, and R101.